Roller-Compacted Concrete Pavement:

Applications, Design, Construction, & Quality Control

ROAD SCHOOL

March 11, 2009

CRT Concrete Consulting, LLC

PCA Portland Cement Association — Concrete Thinking for a sustainable world

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ACPA INDIANA CHAPTER

RCC Pavement

- Definition
- Applications
- Design
- Construction
- Quality Control

Definition

"Roller-Compacted Concrete (RCC) is a no-slump concrete that is compacted by vibratory rollers."

- Zero slump (consistency of DGA)
- No forms
- No reinforcing steel
- No finishing
- Consolidated with vibratory rollers

Concrete pavement placed in a different way!

Benefits of RCCP

- Economical
- High load carrying ability
- Eliminates rutting and spans weak subgrades
- Excellent freeze-thaw durability
- Simple, fast construction
- High production with minimum labor
- Light surface reduces lighting requirements

Logging Yards

Intermodal Yards

Distribution Centers

18 acre distribution center in Austin, TX

10 years after construction

Warehouse Facilities

Parking Areas

200 acre parking lot at
Honda Plant, AL (2004)

134 acre parking lot at
Saturn Plant, TN (1988-89)

Streets & Roads

Highway Shoulders

I-285
Atlanta, GA

Use is Growing

SAVKO
We move the earth.

NICKOLAS SAVKO & SONS, INC

Completed Roller Compacted Concrete Pavement Projects
August 2001 – November 2005

Job Name	Type of Pavement
2001	
City of Gahanna	
Lansdowne Avenue	Complete Street Reconstruction
City of Columbus	
Longwood Subdivision	New Subdivision
Marble Cliff Crossing	New Subdivision
Quarry Pointe	New Subdivision
2002	
City of Columbus	
Alkire Place	New Subdivision
Crawford Farms 6-1	New Subdivision
Creekstone	New Subdivision
Prestwick Green	New Subdivision
The Preserve	New Subdivision
City of Delaware	
Kensington Subdivision	New Subdivision

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NICKOLAS SAVKO & SONS, INC

Completed Roller Compacted Concrete Pavement Projects

Continued

Job Name	Type of Pavement
2002	
City of Grove City	
Grant Run	New Subdivision
City of Pataskala	
Taylor Glen, Section 1	New Subdivision
City of Pickerington	
Longview Subdivision	New Subdivision
City of Reynoldsburg	
Baldwin Road	Complete Street Reconstruction
Park of Waggoner	New Subdivision
Quarry Park 1	New Subdivision
Woods of Reynoldsburg	New Subdivision
Dominion Homes	
Villages at Hilliard Green	New Subdivision
Jack Strader	
Strader's Garden Center	Private Parking Lot

NICKOLAS SAVKO & SONS, INC

Completed Roller Compacted Concrete Pavement Projects

Continued

Job Name	Type of Pavement
2002	
Licking County Engineer	
Cumberland Trails	New Subdivision
Watkins Grove	New Subdivision
Lifestyle Communities	
Waggoner Park	New Subdivision
NOCA LTD	
Panera Bread Store	Private Parking Lot
Ohio State University	
Woody Hayes Drive	Street Reconstruction of a Major Arterial Roadway
Village of Groveport	
Hickory Grove	New Subdivision
Madison Road Replacement	Isolated Street Reconstruction
Village of Sunbury	
Sunbury Estates	New Subdivision

Engineering Properties

- Compressive strength
  - 4,000 to 10,000 psi
- Flexural strength
  - 500 to 1,000 psi
  - $f_r = C(f'_c)^{1/2}$
- Modulus of Elasticity
  - 3,000,000 to 5,500,000 psi
  - $E = C_E(f'_c)^{1/2}$

Thickness Design of RCC Pavements

- Follows rigid pavement design methods
- Plain, undoweled, unreinforced concrete pavement
- PCA's *Structural Design of RCC for Industrial Pavements*
- PCA *RCC-PAVE* Program

Mix Design

Differs from conventional concrete mixture procedures

- Not air-entrained
- Lower water content
- Lower paste content
- Larger fine aggregate content
- Nominal maximum size aggregate (NMSA) +/- 5/8”

Mix Design

- Dry enough to support a vibratory roller
- Wet enough to permit adequate distribution of paste

Aggregate Selection

- Aggregate selection very important
- Responsible for mix workability, segregation, ease of consolidation
- Pre-blended or stored separately

Cementitious Materials

- Select materials based upon availability, economics, and design requirements:
  - Portland cement: Type I or II
  - Fly ash
  - Normally 500 lb/cy cementitious (12% to 17% of dry weight)
  - If used, fly ash proportions are typically 15% to 25%

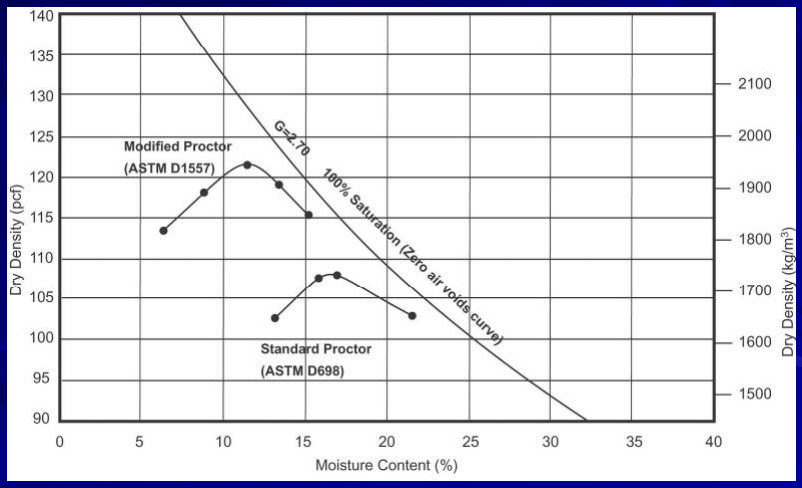
Admixtures

- Retarder or water reducer can be used to increase working time
- Air entrainment not yet technologically possible, but
  - Experience has shown RCC can be made freeze/thaw resistant
  - It's too dense to be saturated

Soil Compaction Method

- Determine moisture content
  - Construct moisture/density curve
  - Modified proctor ASTM D1557
  - Assume a median cement content (e.g. 15 percent)

Standard vs Modified Proctor



Continuous Pug Mill

- High-volume applications
- Excellent mixing efficiency for dry materials
- 250 to 500+ tons/hr
- Mobile
- Erected on site
- Higher mobilization costs

High Volume Production

Central Concrete Batch Plant

- Highly accurate proportioning
- Local availability
- Smaller output capacity
- Longer mix times than conventional concrete
- Frequent cleaning
- Dedicated production

Low Volume Production

Clifton Road Union County, IN

Transporting

- Dump trucks normally used
- Covers required for long hauls, or hot/windy conditions

Subbase/Subgrade Preparation

- Same requirements as conventional concrete
- Must be stiff to provide full compaction
- Stable subgrade
- Non-pumping subbase
- Moisten subbase prior to RCC placement

Placing Equipment

- High density pavers
  - Vibrating screed
  - Dual tamping bars
  - High initial density (90% to 95%)
  - Reduces subsequent compaction
  - High-volume placement (1000 - 2000 tons/shift)
  - Designed for harsh mixes
  - Smoothest RCC surface

High Density Pavers

Placing Equipment

- Conventional Asphalt Pavers
  - Provides some initial density (80%-85%)
  - Relatively smooth surface

Compaction

- Proper compaction is critical for strength and durability
- Compact to 98% of modified Proctor
- Vibratory roller
- Non-vibratory steel wheel roller
- Rubber-tire roller

Curing

- Extremely important for surface durability
- Low moisture in RCC
- Three methods:
  - Moist cure
  - Concrete curing compound
  - Asphalt emulsion

Construction Joints

- Most critical area of project
- Must be constructed properly for durability
- Ensures bond/interlock, so slab acts monolithically
- Three types of construction joints:
  - "Fresh joints"
  - "Cold joints"
  - "Horizontal joints"

Fresh Joint

Tight Fresh Joint

Cracking / Jointing

- Saw-cut joints unnecessary for performance
- Natural cracks provide excellent load transfer due to aggregate interlock
- Saw-cut joints control cracks for aesthetic purposes

Natural Cracks

- Most economical
- ~30ft spacing
- Often first cracks appear within 24 hours
- Narrow crack widths
- Seal if > 1/8-inch
- Best load transfer
- Minimal raveling

Saw-Cut Joints

- More aesthetically pleasing
- Early entry saws very effective, shortly following placement
- Need to saw within 12 hours to avoid uncontrolled cracking
- 1/3 to 1/4 of total layer thickness

Surfacing

- Paver-placed RCC needs no surface for durability
- Adequate for low-speed traffic
- High-density pavers can provide smoothness for medium-speed traffic
- Thin asphalt surface (1-1/2 to 3 inches)
  - Improves surface for high-speed traffic
  - Placed immediately or any time thereafter

Surface Textures

Moisture / Density

Nuclear Gauge
ASTM C1040

Strength Testing

Fabricating Cylinders
With Vibrating Hammer
ASTM C1435

Thickness

Indiana Projects

Henry Count

ent Plant

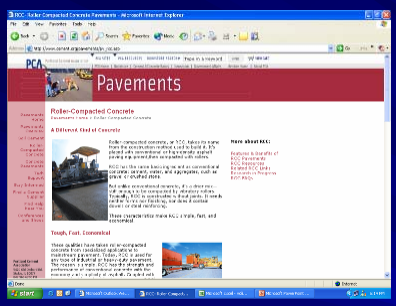
Clifton Rd., Union Co.

St. Joseph County

Browning/Duke Property

Hendricks Co.

for additional information, please visit PCA's website at www.cement.org/pavements



Count on Concrete PAVEMENT

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